A NEW PLETHODONTID SALAMANDER FROM SONORA, MEXICO

By Charles H. Lowe[1], Clyde J. Jones[2], and John W. Wright[3]

Abstract: Recent discovery of a population of plethodontid salamanders in the Sierra Madre Occidental of extreme northwestern Mexico (Sonora) is reported. The population is described as a subspecies of *Pseudoeurycea belli.* Remarks on systematics, ecology, and biogeography are included.

A series of plethodontid salamanders were recently collected in the Sierra Madre Occidental, in southeastern Sonora, Mexico, by two field parties (see Remarks concerning itinerary and logistics) and represent the first plethodontid salamanders from northwestern Mexico. We consider them as representing a distinctive, undescribed northern subspecies of *Pseudoeurycea belli* Gray, and therefore propose:

Pseudoeurycea belli sierraoccidentalis subsp. nov.

Fig. 1

Holotype: University of Arizona, Department of Zoology (UAZ) No. 12138; Field No. CJJ 3654. Collected at *ca.* 11 mi (rd) E Santa Ana, on old road to Yécora (*ca.* 0.5 mi W Rancho El Puerto), Sonora, Mexico, by Clyde J. Jones, Charles H. Lowe, and John W. Wright, September 7, 1964. We estimate the locality to be 21 ± 1 km WSW Yécora, by old road to Nuri.

Paratypes: UAZ 12139-12141, 12143, LACM 39200-01, all topoparatypes.

Diagnosis: Distinguished most readily from other populations of *Pseudoeurycea belli* by a color pattern of a few (minimum, five) red spots of unequal size and shape scattered on the upper black body surfaces, occasionally coalesced along midline, and sometimes bilaterally paired; occipital blotches absent (Figs. 1 and 2); feet with moderately developed webbing between toes, and with the web-free toe length conspicuously short (Fig. 3).

Description of Holotype (*measurements in millimeters*): Adult male, prepared in field on capture (fixed in formalin, now in alcohol). Hedonic gland on chin pronounced, 7.0 wide, 4.8 long (on ventral midline). Gular fold aberrant—not a single fold in a smooth transverse line.

Snout-vent length (to posterior end of vent), 86; tail with prominent basal constriction; tail length, 68; tail width (greatest diameter at base, the tail

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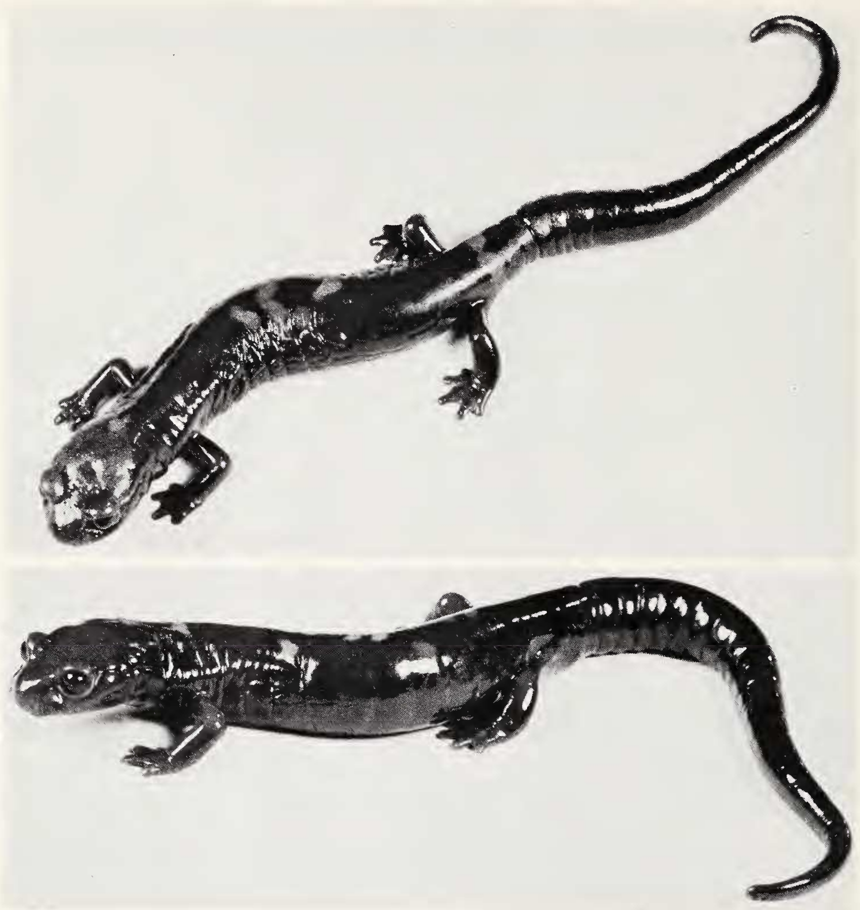

Figure 1. *Pseudoeurycea belli sierraoccidentalis* from the type locality, Sonora, Mexico. Above, adult female (UAZ 12143); below, adult male (LACM 39201).

intact), 9.1; foreleg, 19; hindleg, 19; width of foot, 7.2; snout-foreleg, 25; eye (anterior to posterior corner of lower eyelid), 5.0; head length (snout-gular fold), 19; head width, 14.5; snout-anterior corner of eyelid, 5.7; width between nostrils, 5.2; minimum interorbital distance, 3.9. Costal folds 13, counting one each in axilla and groin, three between adpressed limbs. Moderately developed webbing between toes and fingers; ascending order of size of toes, 1, 5, 2, 4, 3; of fingers, 1, 4, 2, 3. Vomerine teeth in two strongly arched (posteriorly) series, not contacting medially and extended mesially beyond choanae. Parasphenoid ("paravomerine") teeth in two contiguous groups separated anteriorly from the vomerine ("prevomerine") series.

Length of head 22.1 per cent of snout-vent length. Equivalent head length into snout-vent length, 4.53 times; this value is higher than for all other specimens in the series, due to the aberrant gular fold involved in the measurement (see *Variation*, below); head width into snout-vent length, 5.93 times.

Colors in life, black above and black to blackish below, with 12 dark red dorsal spots. Distribution of the red spots is as follows (Fig. 2): seven on the body between front and hind limb insertions, two on the body posterior to the hindlegs, two on the neck, and one on the midline across the juncture between neck and head. None of the spots are paired bilaterally on costal folds. There are neither occipital blotches, enlarged or otherwise, nor spotting on the head other than the single small midline spot across the transverse neck-line. The greatest diameter for the three largest spots of the seven on the body between axilla and groin are 3.7, 3.7, 4.2; each of these three spots is positioned obliquely, lies to the right of the midline, and is centered more or less on a costal fold (Fig. 2).

Variation: The series consists of seven specimens: four large adults with snout-vent lengths (mm) of 92 (♀), 88 (♀), 86 (♂), and 80 (♂); an apparent subadult (S-V L, 64 mm); and two smaller immature individuals (S-V L, 49 and 50 mm).

The number of dorsal red spots differs for each of the seven individuals. The variation, nevertheless, is within a pattern of a basic bilateral arrangement associated with the costal folds, typical of the species *P. belli* (Fig. 2). The number of red spots varies from eight to thirteen (8, 10, 12, 13; mean 10.8) in the four adults. The total number of red spots for the three small specimens is five to twenty six (5, 5, 26; mean 12.0); the one individual (juvenile) that was assigned a number of 26 has approximately 20 red "spots" with approximately six additional minute red "flecks" not clearly visible to the unaided eye. Except for this one juvenile, 13 spots is the maximum number for the series, and the mean for the entire series ($N = 7$) is 11.30. *P. b. belli* usually has a minimum number exceeding 30, including a pair of occipital blotches.

The colors in life were recorded when the body temperatures of the animals were in the range 10-15° C. The ground color of the dorsal surface is black, lightening on the ventro-lateral surfaces, and grading to blackish gray on the ventral surfaces. The dark red spots on the dorsal surface (Fig. 2) vary from bright dark red (Maerz and Paul, 1930, 6-L-1) to deeper dark reds, varying from near Brazil red (4-K-12) and Buccaneer (4-L-12) to Chrysanthemum (5-L-12). With preservation in alcohol, the red color of the spots of *P. belli* fades through pinks to orange-reds and reddish-orange, and finally to orange, yellow, or yellowish. The iris is dark brown in life, striated with black lines radiating more or less from the pupil.

Females may exceed males in body size, as in our sample. The length of the hindleg exceeds the length of the foreleg by a very small amount, on the order of one millimeter or less. The holotype may be representative of the length difference between foreleg and hindleg for males, which appears to be

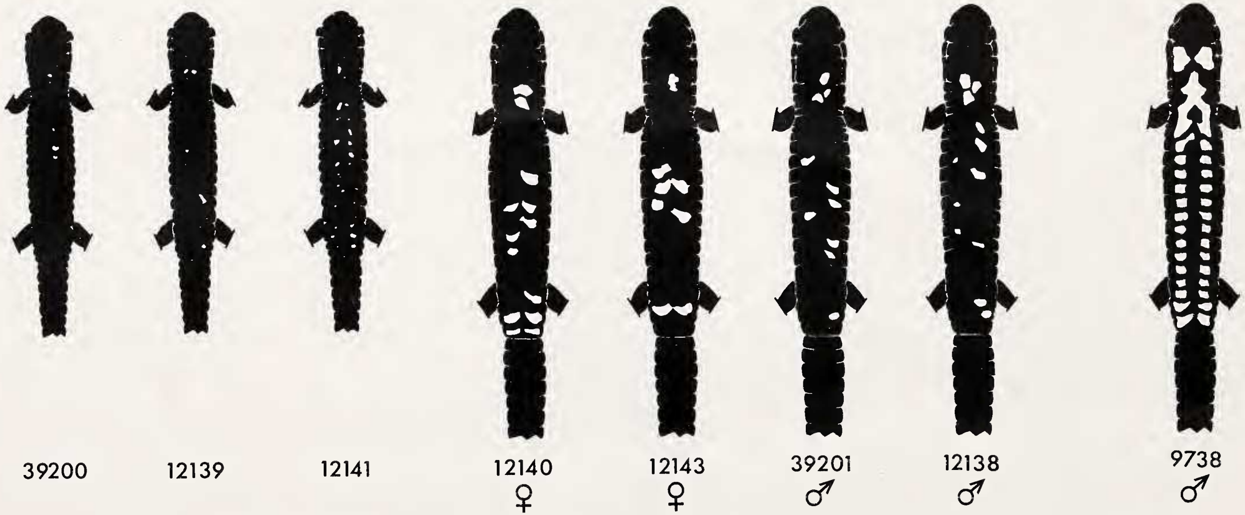

Figure 2. *Pseudoeurycea belli sierraoccidentalis* (type series) from Sonora, and *P. b. belli* (UAZ 9738) from Michoacan. Not drawn to scale.

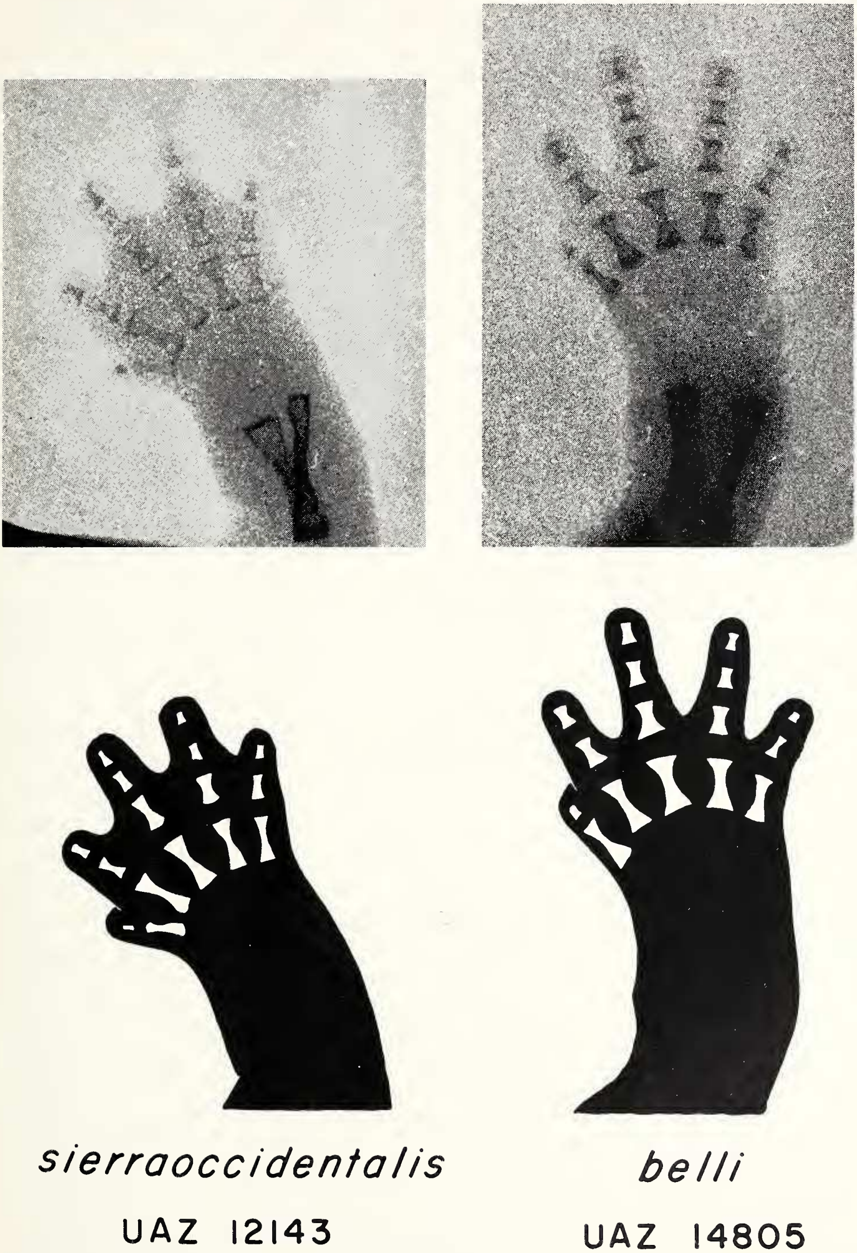

Figure 3. X-ray (dorsal view) and drawing of right hind foot of *Pseudoeurycea belli sierraoccidentalis* (left) from Sonora, and *P. b. belli* (right) from Jalisco.

negligible when the data are rounded to the nearest mm. The ranges of variation for all seven specimens are 12-20 mm for foreleg and 12-21 mm for hindleg.

There are 12 costal folds and 13 costal grooves, counting one each in axilla and groin. In the three small individuals in the series, the 12th costal groove (counting from front leg toward hind leg) is indistinct.

Comparisons: The configuration, juxtaposition and degree of separation of the parasphenoid and vomerine teeth are essentially as in other populations of *P. belli.*

The proportions of some of the body parts of *P. b. sierraoccidentalis* differ from those of comparative material of *P. b. belli* from Jalisco and Michoacan (UAZ 9738, 14805-14811). The toes (web-free toe length) of *b. sierraoccidentalis* are conspicuously short, and their free length is reduced to a half to a third of comparable toes on the same foot of similar size in *b. belli* from Jalisco and Michoacan (Fig. 2). The X-rays of the feet of *b. belli* and *b. sierraoccidentalis* show that the web of *b. sierraoccidentalis* extends anteriad of one additional bone in the digit (Fig. 3).

Overall size of phalanges, legs and feet of *b. sierraoccidentalis* appears to be smaller than in the comparative material of *b. belli* from other regions; because of ontogenetic variation and the small size of our sample, these and some other questions regarding proportional differences between populations can be better answered when larger series of *b. sierraoccidentalis* become available.

We observed the tail to be especially easily dropped on the very slightest pressure against the substratum or other surface, when the animal is excited. These data refer to the type series of *P. belli sierraoccidentalis* (N = 7) in which 57.1 per cent (four out of seven) dropped their tails when they were alive and gently handled—two of four adults (1 ad. ♂, 1 ad. ♀), and two of three immatures. Wake and Dresner (1967), recently reported on tail autotomy in salamanders, and concluded that the degree of tail loss in species with basal tail constriction is more complete but *less frequent* than in their less specialized relatives. *Pseudoeurycea belli sierraoccidentalis*, to the contrary, is a salamander with a pronounced basal constriction, and 57 percent tail loss appears indeed high (see Wake and Dresner, 1967, Table 2) even though the sample available in this case is small (N = 7). The highest tail-break percentage given by Wake and Dresner (1967, Table 2) is 33.4 percent for *Desmognathus fuscus*, a species with a thick-based (non-constricted base) tail; their average for seven non-constricted base species is 23.0%, versus 9.5% for thirteen species with basal constrictions, a difference that is significant at the .001 level. Their sample size varied from N = 46 to N = 757 specimens per species.

Typical of the terrestrial plethodontids with tail base constrictions (the site of tail autotomy), *P. b. sierraoccidentalis* is a "gentle" salamander. It is obvious enough that it exhibits a very definite behavioral control over tail loss, and that within the family a combination of voluntary and mechanical factors are involved in the breakage of tails at points of constriction, at least in the most highly specialized species (Wake and Dresner, 1967). These authors emphasize in conclusion that the salamander tail is a very important, highly functional organ and suggest that selection has been for behavioral and anatomical adaptations for control of tail loss, rather than for tail loss per se.

Habitat: The habitat is in a generally east-west oriented barranca, the upper end of which terminates between the salamander localities and Rancho El Puerto (roughly 5,000 ft). Rancho El Puerto is just to the east of a small divide that parts two drainage systems, and is located at the upper end of another canyon with drainage more to the south and apparently into parts of the state of Chihuahua.

The old road to Yécora is in the bottom of this canyon, which may be as much as 50 but usually is less than 10 yds wide. The canyon floor is loose rock rubble with a stream occasionally flowing over and through it. There is a gradual slope of roughly 30 degrees to either side of the floor, tapering to the 60 degree slope of high canyon walls. The height of the canyon walls varies, but in general they appeared to be approximately 300 ft or more in height at the collection sites.

Numerous short, small side-canyons enter this main canyon from both the north and south-facing slopes, and in three of these (north-facing) the salamanders were located. These side-canyons are quite steep, with many small waterfalls along their courses. It could not be determined if the side-canyons possessed permanent water, but many in the area are in part spring fed. The major stream in the main canyon (barranca) bottom appears to have constant water and is fairly swift, due to a general 20 degree westward downslope.

The substratum on the canyon sides consists of humus-rich soil overlying rather loosely consolidated and often deeply jumbled exfoliated rock (rock rubble) from the canyon walls. In some areas this situation is interrupted by outcroppings of thinly laminated shalelike limestone bluffs. The bedding of the parent material is almost upright and has large vertical fractures. Many large volcanic boulders are scattered along the stream-course, having been carried down from the upper canyon walls.

The present dominant vegetation consists of oaks (*Quercus*, mainly *Q. hypoleucoides*), scattered madrones (*Arbutus mexicana*), and young apache pines (*Pinus englemanni*). It is obvious that the area has been logged at some earlier time, as judged from the number of large old pine stumps. Some of these may have been Chihuahua pines (*Pinus leiophylla*), a prominent species of the Madrean Oak-pine Woodland which was noted nearby on some adjacent higher slopes. Part of the mesic understory and ground cover of forbs was apparently due to the abundance of surface and subsurface water in the area during the summer monsoon. That general conditions are more humid in this particular north-facing habitat than in some others of similar nature nearby, is further indicated by conspicuously large numbers of the bromeliad *Tillandsia recurvata* on some of the oaks.

The salamanders were collected during a period of several days of torrential summer rains (Sept. 2-7). All of the salamanders found were associated with rather sizable fallen logs, mainly pine, in one instance oak. Some of the logs investigated for the presence of salamanders were as much as four feet in diameter and were for the most part saturated with water and partially buried in the moist humus and soil. The only logs that sheltered salamanders were located in exposures where almost no direct sunlight could strike them at any time of day, and where loose, deep and wet rock rubble also occurred. These areas were located in the southern half of the barranca bottom and within the smaller side canyons of the north-facing slope. Cloacal and substratum temperatures recorded on capture for the four adult salamanders (16.5-17.3°C) varied less than one degree centigrade for all observations. It is unlikely that the diurnal temperature of the underlog salamander microenvironment at the type locality exceeds 20°C during the summer monsoon (June-October).

Although our sample is small, there may be a relationship between the size of the individual and its microhabitat as observed in early September. All of the smaller individuals (three) were found within wet logs, whereas all of the large (adult) individuals (four) were found under large logs in small depressions in the humus and soil.

A small spider was regurgitated by one salamander as it was being preserved on capture.

Remarks—Itinerary and Logistics: The salamanders were collected by two field parties in September, 1964. The first party of four—Thomas J. Cox (formerly U.A., Zoology), and John W. Wright, Dr. Kenneth L. Hale (formerly U.A., Anthropology), and Dr. Clyde J. Jones—was trucked by Mr. Cox into the foothills of the Sierra Madre Occidental via Ciudad Obregón and Nuri, with Yécora as destination. The purpose of the trip was to record the Pima language and to collect vertebrates encountered enroute. Dr. Jones collected a small black salamander in a wet log streamside and roadside to the old road to Yécora, above Nuri (the type locality). The specimen was collected during the evening, on a long return hike from Yécora to the vicinity of Santa Ana (below the type locality), where the truck had stopped the day before. As the party was pressed for time, it returned directly to the University of Arizona on September 5.

On the following morning, September 6, the second field party (authors) left Tucson for Yécora with bush-pilot Mr. David Vactor of Tucson, in Mr. Vactor's Cessna 180, and landed on the air strip at Yécora at 11:00 a.m. Pack animals were obtained from Mr. Gordon MacMurray of Yécora and the salamander locality was reached that night during a lengthy rainstorm. On the morning of September 7, a series of six additional individuals of *Pseudoeurycea belli* (four adults, two young) were collected in the area, all in or under wet (soaked) logs of pine and oak. We returned to Yécora before dark and headed immediately for Tucson by air via Hermosillo, with four of the six salamanders alive in wet cloth sacks on ice in a small styrofoam bucket; the other two salamanders were preserved on capture.

Remarks—Species versus Subspecies: The Sonoran population described here is allopatric with *Pseudoeurycea belli* to the south, and the geographic gap is a respectable distance (see *Biogeography*, below). We note that Taylor's (1938) *P. gigantea* from Veracruz is less distinct from *P. belli* than is the Sonoran population described here as a subspecies. If Taylor's allocation to species (*P. gigantea*) is correct for the Veracruz population, it would appear that the Sonoran population could be expected to be specifically distinct from *P. belli*, the relationship which we regard at this time as least likely.

Taylor's (1938) opinion on *P. gigantea* was contrary to Dunn's (1926). Dunn originally considered the material of Taylor's *P. gigantea* (including live animals Dunn collected in Veracruz) to be within the range of variation of *P. belli*. *Pseudoeurycea gigantea* Taylor is distinctive and allopatric. The question is whether it should be regarded as a species or subspecies.

Remarks—Southwestern Mountains: With the discovery of *Pseudoeurycea* in Sonora, the old record of *Oedipus bellii* from Arizona obviously deserves reconsideration. Dunn (1926:360) listed the species for Arizona in his monograph on the Plethodontidae, but gave the matter no further consideration than the following line in his listing of localities: "United States: Arizona: Ft. Whipple 3 (U.S.N.M., uncatalogued, now lost)." Taylor (1938:266) stated that the record of this species from Arizona should be questioned, and that, although listed by Dunn, it was "apparently doubted by him." Later Taylor (1941) reiterated his conclusion, and subsequently (Lowe, 1955) there seemed no point in attempting to revive the old question, since field work during 1950-1955 in the Bradshaw Mountains and others had been unsuccessful.

Since 1950 one or more of us have made periodic and unsuccessful trips into the Bradshaw Mountain area of Arizona and into other Arizona, New Mexico, Sonora, and Sinaloa ranges during the summer monsoon, in an effort to locate plethodontid salamanders at or near the provenance of the lost USNM *Oedipus bellii* from Fort Whipple (vicinity Prescott), *fide* Dunn (1926). A still further concentrated effort is now indicated for Arizona-New Mexico-Sonora, in ranges such as the Bradshaws, Chiricahuas, Pinaleños, and Mogollons, which are Cordillieran outliers positioned between the Sierra Madre and the Rockies. Some of the attendant seasonal field problems encountered in such work in the Southwest and in Mexico are indicated by Taylor (1944: 216), Lowe (1950:96, 1955:250), and Stebbins (1951:79).

Biogeography: The discovery of *Pseudoeurycea belli* in the Sierra Madre Occidental near its northern end in Sonora, is of biogeographic interest and importance. Plethodontid salamanders have not been reported previously from the west coast of Mexico north of Sierra de Nayarit (*Oedipus bellii*, Gadow 1905, unconfirmed). The locality in Sonora, near the confluence of the state lines of Sonora-Chihuahua-Sinaloa, extends the known range of the species roughly 550 miles[4] northward from the previously recorded locality (Sierra de Nayarit), and across nearly the entirety of the south-north oriented Sierra Madre Occidental.

While Taylor (1944:212) considered such an eventuality as somewhat dubious, Dunn (1926, and elsewhere) either did not consider the situation possible or, less likely, he did not consider it at all. Dunn's (1926) apparent dismissal of the old "Arizona" specimens of *Oedipus bellii* (USNM, lost) as of any biogeographic importance is understandable. In addition to representing an unlikely provenance for what was then thought to be a species occurring only in "South Central Mexico," such a unique Arizona occurrence of *Oedipus bellii* (= *Pseudoeurycea belli*) might have been considered contrary to parts of his thesis on the origin and evolution of the family Plethodontidae.

According to Wake's (1966) recent reclassification of the family Plethodontidae, *Pseudoeurycea* is one of the genera in the supergenus *Bolitoglossa*, in the tribe Bolitoglossini in the subfamily Plethodontinae. Wake considers bolitoglossine salamanders (supergenera *Batrachoseps*, *Hydromantes*, and *Bolitoglossa*, including *Pseudoeurycea*) to have been established early as a group, possibly in early Tertiary or even late Cretaceous. He places that event, and other major evolutionary events in the Plethodontidae, in Appalachia in eastern North America, as did Wilder and Dunn (1920) and Dunn (1926). According to Wake (1966), the plethodonine salamanders (genera *Aneides, Ensatina, Plethodon*)—the second terrestrial group—diverged in Appalachia later than the bolitoglossine divergence. While plethodonines occur today in both western and eastern North America, the bolitoglossines occur only in western North America.

The present discovery of *Pseudoeurycea* near the juncture of the 30th parallel and 110th meridian in Sonora, Mexico, while surprising as a sizable as well as an unexpected northwestward extension of a supposed southern genus virtually into the United States, is consistent with major outlines of bolitoglossine salamander evolution as described by Wake (1966). It is also consistent with hypotheses in the recent report by Regal (1966), published simultaneously with that of Wake, in which Regal places the geography of the major evolutionary events in the family Plethodontidae in western rather than in eastern North America. While Wake (1963, 1966) agrees that the indirect evidence available warrants a hypothesis that western North America has been an important center of plethodontid radiation, he argues in support of Dunn's (1926) thesis that the basic radiation was centered in eastern North America (Wake, 1966).

ACKNOWLEDGMENTS

Mr. Alfred P. Gardner (Louisiana State University, Zoology) kindly collected for us during the summer of 1965 a large series of *Pseudoeurycea*

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[4] Map distance between Yécora and Tepic varies with the cartographer and publisher; it is on the order of 550 ± 25 airline miles.

belli in the Nevado de Colima, Jalisco, Mexico. Figures 2 and 3 were drawn by Mr. James L. Patton, Department of Zoology, The University of Arizona.

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